IMPLEMENTATION OF LINUX VIRTUAL SERVER NETWORK ADDRESS TRANSLATION FOR LOAD BALANCING AT BINA DARMA UNIVERSITY E-LEARNING SERVER

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ABSTRACT

The quality of information system services in an organization basically depends on its existing infrastructure. In Bina Darma University (BDU), servers are designed not only to work as a server machine but also have a function of the applications. One of its functions is to provide and to facilitate e-learning applications in supporting teaching and learning process for almost 4437 users, include students and staffs. Problems arose when such big users do various activities in system that must be completed within a time. As result, Apache connection was flooded with requests that exceed servers' capability, and many processes cannot be completed. Our paper considers an implementation of Linux Virtual Server Network Address Translation (LVS NAT) to overcome this problem. We employed LVS as a load balancer infrastructure in UBD e-learning server. We designed a computer unit that acts as a director and two or more computers that act as real server. From observation, we found that the performance of e-learning server increase in handling Apache services. Servers still work at required condition although HTTP was flooded by requests.

KEYWORDS

e-Learning, Load Balancing, Linux Virtual Server, Network Address Translation

1. INTRODUCTION

E-learning is internet-enabled learning that include content delivery in multiple formats, management of the learning experience, and a networked community of learners, content developers and experts (Gunasekaran, et. al., 2002). As a concept of virtual learning, e-learning system could improve student motivation and their interest in studying as well as students' perceptions on their success (Chen, Y, et. al., 2012). It provides several benefits, such as: increased accessibility to information, better content delivery, personalized instruction, content standardization, accountability, on-demand availability, self-pacing, interactivity, confidence, and increased convenience. E-learning reduces costs, enables a consistent delivery of content, and improves tracking, among other benefits for faculty (Bhuasiri, W, et. al., 2012). Beside that, the successful implementation of e-learning requires a management commitment (Henry, 2001).

Provision of a qualified information system and services in companies, organizations, or educational institutions that run computer-based system basically depend on their existing infrastructure. Data and information used in information system are stored in a computer called a server machine. At Bina Darma University (BDU), servers have functions of the application as well as a server. It provided very important roles in carrying out teaching and learning activities. One role of server is running e-learning applications to support teaching and learning process. Using e-learning, student as well as lectures will have a supporting system as well as materials beside their regular meeting in class. They can access e-learning facilities through university website and log in through http://elearning.binadarma.ac.id.

Daily operational of e-learning system at BDU is controlled by a special technical unit called *Unit Pelaksana Teknis Sistem Informasi Manajemen* (UPT-SIM). They operate and control e-learning system and its infrastructures. BDU currently uses a web-based e-learning services and Apache web server. Apache HTTP server (http://www.Apache.org) is used not only because it is open source and is one of software that widely used on Linux operating system's family but it also provide advantages of the flexibility and performance, such as:(a) high degree of stability, (b) overall application and additional modules are open

source, (c) works on many operating system platforms and architectures, (d) provide a good level of security, and (e) could be integrated with PHP and MySQL.

UPT-SIM recorded that e-learning server must serve (in average) 4437 users with various activities, such as upload and download material, discussion, chat and class examination. That big number of users result problems at BDU webserver, especially during the active semester. When the number of activities that should be completed within a time increased, Apache connection was flooded with requests that exceed its maximum load limit. It result a lot of number of unresolved processes. As example, there is a case of non-completion process HTTP quoted from the log records of e-learning server: **"Jun 2 12:09:42 SERVER elearning kernel: [770645.647316] possible SYN flooding on port 80. Sending cookies"**. This message appears due to a number of processes that should be resolved but cannot be completed. Apache, by default, does not have the ability to set the load as in the IIS/NT. If there are requests, Apache will continue forking on HTTP process. As the result, it could be used as a hanging down socket attack that resulted services of the server down until MaxClients limit allowed by the operating system is exceeded. Beside that, the number of contents that are uploaded or downloaded in e-learning server as well as its size could also reduce the quality and stop its services. Typically an organization that utilizes web to support their activities should analyze the facilities, capabilities, and uses of their web server technology (Gozali & Alex, 2002).

To cover those problems, UPT-SIM tried to optimize the configuration of e-learning system. Several actions was undertaken, such as increasing the amount of memory limit, lowering the timeout value of each connection to Apache, and increasing MySQL memory database as well as refreshing the table every day. It is important policy due to a complexity of handling a high server loading condition, which could be solved only using expensive super computer (Zulhaidi & Dipojono, 2002). It is possible to use load balancing cluster method to overcome this economical issue. Clustering is a composite of several computers that work together to produce the output of a particular problem given (input), where the system developer is required to manually divide jobs to each member of the networked computer. Load balancing is a solution to overcome the problem by dividing e-learning load to multiple computer servers. This method is able to deliver and maintain availability of services (Kim, M et.al., 2002, Rijayana, 2005, Taryana & Siswantoro, 2010). By implementing load balancing we could possible stabilize a whole network because it ensures the high level of network service availability (Taryana & Siswantoro, 2010).

In this paper, we discuss the application of Linux Virtual Server (LVS) as a load balancing mechanism. LVS is chosen due to its good performance and throughput (Kim,M, et. al., 2002). There are 3 (three) types of IP load balancing techniques (packet forwarding methods) using virtual server, namely: (a) virtual server via network address translation (NAT); (b) virtual server via IP tunneling; and (c) virtual server via direct routing. We implement virtual server via NAT by providing a computer unit that acts as a director and two or more computers that act as the real servers. We found that the coordination of multiple servers that was implemented to handle all requests will reduce load processing.

2. LINUX VIRTUAL SERVER (LVS)

LVS is an open source project that provides a server cluster. It is a highly scalable and highly available server built on a cluster of real servers, with the load balancer running on the Linux operating system. A virtual server is a server that is easy to be developed and built a high level of availability of independent server clusters (www.linuxvirtualserver.org). The architecture of server cluster is transparent to end-user where each user will interact individually to system as a highly performed virtual server.

The LVS consists of one load balancer and several real servers (Kim, M, et. al., 2002). LVS is one type of load cluster management system that supports a fault tolerant and stable service. The load balancer receives all requests from clients and distributes them to a real server using an appropriate scheduling algorithm, such as round-robin (RR), weighted round robin (WRR), least-connection (LC) or weighted least-connection (WLC). As load balancer, there are 3 (three) types of load balancing techniques, namely (a) virtual server via network address translation (NAT); (b) virtual server via IP tunneling; and (c) virtual server via direct routing.

The real servers are the computers holding the actual services, such as web, mail, ftp, dns, etc. The real servers are also units that serve the request. Real servers are connected through a high speed LAN or by a distributed WAN that could run on several operating system that support TCP/IP. The request of the clients and the front-end of the cluster of servers is the director, which appears as a single-server to the clients and thus is called virtual server.

3. RESEARCH FRAMEWORK

Our research was conducted in May to July 2011 at the Technical Services Unit, Management Information System Bina Darma University. We design the implementation of LVS NAT as a load balancer (Figure 1). It includes determination of hardware used, topology of network, and scheduling algorithms as well as the testing mechanism of LVS NAT.

Beside that, we also conducted requirements analysis to observe what user and management needs, which result:

The user needs

The ease and availability of network connectivity and e-learning modules at any time either of the intranet and the internet. E-learning resourcesweredesigned for students to download and upload the content of the course material starting from a size of 1 MB to 32 MB. The activity was conducted using a browser application on student computers. Time of connection to download and upload in e-elarning must be consistent with the session that is open, as well as other activities such as students and faculties working on quiz and exam questions should not be interruptedin answering directly in the session. If the session was lost then the history of all the answers and the questions deleted. Maintain the consistency of the HTTP service is a major problem to be solved from the user level.

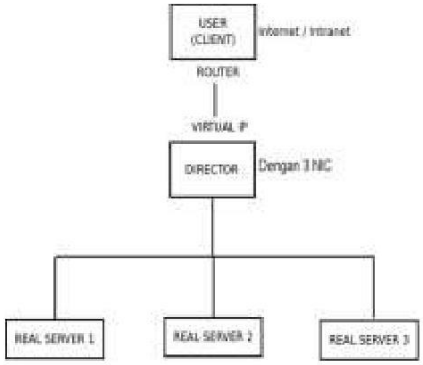

Figure 1. NAT LVS scheme

Management needs

Several aspects should be addressed in analysis:

- a consistent balance loading when provide HTTP services compare to Apache services, so that the session provided to users through e-learning is consistently maintained,
- availability of MySQL database in respondingtwo units real server, if there was a continue connection from HTTP services, and presenting the latest information of any user activities in every session that responded by PHP connection,
- ability of directors in dividing any requestsand distributingit to the real server in order to share the load evenly based on schedule that has been designed previously,

providing data sharing that will be used by the real servers in the enabling users to download and upload large-size files.

4. LVS NAT DESIGN

4.1. E-learning topology NAT LVS

The design of NAT LVS is based on the needs and problems that arise frequently. The typical problems in e-learning process were the incapability of a service in finishing the process and ignoring the requests coming result low level of system availability. NAT LVS is designed with several supporting components that are consideredable to solve problems that are designed with a layered topology.

Topology of NAT LVS is quite similar with topology of LAN, which is closed network. It is connected to external network through an intermediary called director. Real server works in private and process tasks based on request provided by the director. A director collects all coming requests and distributes it to the real server using scheduling algorithm. Scheduling algorithm will declare ports that are opened and forwarded. The purpose of declaring port in director is to provide better demand handling and focus to forward it to the real server. Topology and the mechanism are shown in Figure 2.

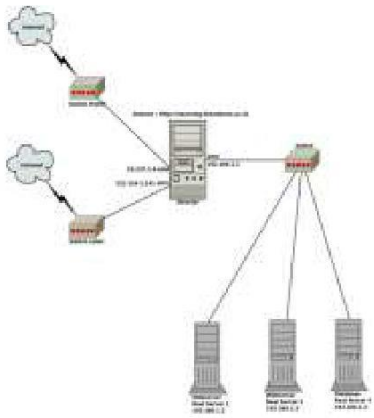

Figure 2. NAT LVS topology

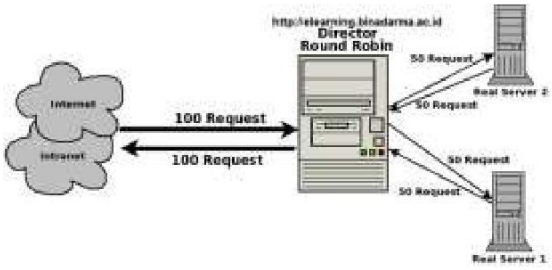

Figure 3. Package sharing NAT LVS

4.2. Load characteristics of E-learning Development Bina Darma University

In daily operational activities, UBD e-learning server serves various activities. Lecturers as the main players in the operational use of e-learning using it as a medium to provide their course materials to students. They could upload various types of file including doc, pdf and ppt files to e-learning. This activity would not overload the server performance, because lectures submit their documents not in the same time. From the observations we observed that a heavy load occurs when the students working on online exam. In online exam, when lecturer provide questions and students start to answer, loading system will increase because the server must retain and open a session each time the student answered the question directly.

We observed that the peak load of e-learning system occurs in the weeks of quizzes exam, midterms and final exams every semester. In those occasions, the number of sessions that should be maintained by the Apache will exceed its capability due to the large number of connections that must be opened simultaneously.

4.3. Load Sharing Mechanism

Director serves as an intermediary between the external network and internal network, where packets coming towards e-learning system will be separated based on scheduling that has been declared. The flow of incoming packets from the intranet and the Internet is consistently divided into two directions toward the real server (Figure 3).

5. IMPLEMENTATION

5.1. Configuration

In this paper we observed 3 (three) network cards that are used in machines director. Every network card connected to different network configurations created by the/etc/ network/ interfaces.

The next step of director configuration is installation of ipvsadm tools that is used to declare a scheduled incoming package, which will be forwarded to real servers in a LVS NAT environment. In addition, director will also be configured as a gateway by editing the sysctl.conf file followed by a command iptables to perform NAT. Based on provided topology (Fig. 2), the real server1 and real server2 will work as a web server. Basically the configuration and tools that exist on a real server 1 is similar with real server 2. The difference of these two real servers is only on the configuration of IP Address (Fig. 4,5). After that, we install LAMPP using **sudo apt-get install apache2 php5-mysql libapache2-mod-php5**, and place or copy CMS moodle in the folder **/var/www** and change file **config.php**.

Real server3 is a computer that functioned as a database server as well as file server. It uses the IP address 192.168.1.4. We use MySQL version 5 as database.

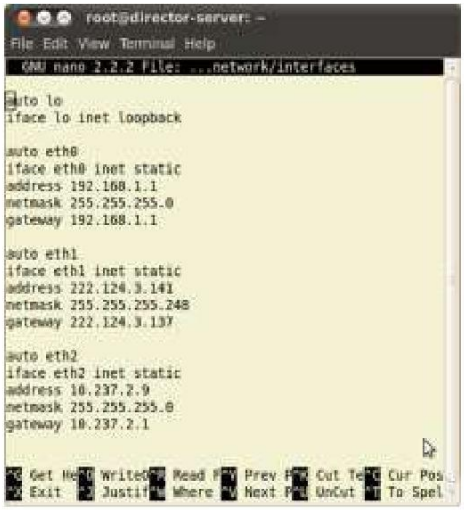

Figure 4. IP address Director

Figure 5. Real server IP address

5.2. Round Robin Scheduling

Scheduling declarations was made into two groups based on the network handled (Fig. 6). On local access and public access is seen that the declaration is repeated but with a different network. The first line of local access declares the IP address as a virtual service using round robin scheduling. The second and third lines define each in coming packet using port 80 that will be forwarded to the real server 1 and real server 2 for each of 5 loads every real server. On public access, the first line states the IP address as a virtual service. Second and third row states that every incoming packet using port 80 that will be forwarded to the real server 1 and real server 2 to each of 5 load.

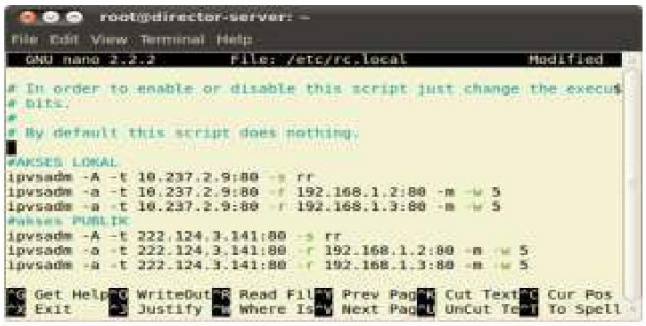

Figure 6. Round Robin scheduling

5.3. Director Performance

The performance of scheduling could be observed by examining whether the incoming packets to the virtual server can be forwarded to the real server or not. Observations made using the ipvsadm command watch-n1 ipvsadm-ln. Using this, we enable to display each coming packet to the director real time. The real time monitoring will provide us the number of coming connections and connection to real servers.

5.4. Testing

5.4.1. Availability Test

Testing of e-learning after using LVS NAT is considered necessary as a reference to prove whether the level of service availability could be increased. In these tests we expect any results in the form of numbers and pictures to prove that LVS NAT is able to share the load process should be completed by e-learning. We conducted testing on HTTP services and LVS network topology. Several tools standard are used to test the endurance of a website services. We use tools ab to test Apache. Tests were conducted from two directions, i.e. Intranet and Internet using 8 (eight) computers that acts as client. Each client will send the1000 packets in 10 stages through port 80.

When we performed ab test, we also tried to access e-learning services in order to prove that a high load of Apache does not eliminate the availability of e-learning services. The test results could be seen in Table 1.

Table 1. Testing results of ab

No	Network	No of Packets	Respond	Time (s)
1	Intranet	1000	243	526.559
2	Intranet	1000	239	517.267
3	Intranet	1000	48	543.123
4	Intranet	1000	37	548.415
5	Intranet	1000	14	574.647
6	Intranet	1000	292	700.007
7	Intranet	1000	200	647.784
8	Intranet	1000	161	753.003

By running the top command in terminal, it is clear that the Apache service has a very high workload when it is flooded with thousands of incoming packets simultaneously. Apache service was ranked as one of the most high. Apache even loaded with a layered process, a process that comes unfinished, but a new process that continually come. We still capable to access e-learning and using the facilities provided with no significant interference.

5.4.2. Measuring Response Time e-Learning

To measure the response time of e-learning, we used the httperf tool that runs on the Linux operating system. By using httperf we provide the response time, throughput and request a lost of e-learning services. To use httperf we did install using command **sudo apt-get install httperf**. We use the same topology for httperf stools as we use ab tools. Command httperf used is simple: **httperf –hog-elearning.binadarma.ac.id server-num-conn 100-1000-ra timeout 5**. Command will send packets to the el-earning server: **elearning.binadarma.ac.id** with 1000 connections. We run commands simultaneously on 8 (eight) computers unit to get full-loaded server condition. We observed time response values from the reply rate, throughput from the miscellaneous section of the Net I/O, and request lost, from the error section of connrefused and connreset

6. CONCLUSION

In this research, we observe the implementation of Linux Virtual Server (LVS) using Network Address Translation (NAT) in Bina Darma University e-learning system. We provide a configuration consist of a director and several real servers. We observed that LVS NAT could improve system capability in handling increment loading on Apache services. We observed that e-learning server still capable provide services in HTTP flooding of request. For future development, we recommend UBD implement a dynamic load balancing system.

REFERENCES

Bhuasiri, W, Xaymoungkhoun, O, Zo, H, Rho, J.J., Ciganek, A.P., 2012, Critical success factors for e-learning in developing countries: A comparative analysis between ICT experts and faculty, *Computers & Education*, Vol. 58, pp. 843-855

Chen, Y, Little Jr, H.T., Ross, M.T., Zhao, Q, 2012, Factors motivating the adoption of e-learning technologies, *Journal of e-Learning & Higher Education*, Vol. 2012, 17 pages.

Gozali, F., Alex, 2002, Virtual Server, *JETri*, Vol. 2 No. 1, pp. 53-68.

Gunasekaran, A, McNeil, R.D, and Shaul, D, 2002, E-learning: research and applications, *J Industrial and Commercial Training*, Vol. 34 No. 2, pp 44-53.

Henry, P, 2001, E-learning technology, content and services, *Education + Training*, Vol. 43 No. 4, pp 249-255.

Kim, M, Choi, M, Hong, J.W., 2002, A load cluster management system using SNMP and web, *International Journal of Network Management*. Vol. 12, pp 367-378.

Rijayana, I, 2005, Load Balancing Technology to Overcome Load Server (Translation of Teknologi Load Balancing Untuk Mengatasi Beban Server), *Proceeding of Seminar Nasional Aplikasi Teknologi Informasi SNATI 2005*, Yogyakarta, Indonesia, pp H35-H39.

Taryana, A, Siswantoro, H, 2010, The application of Clustered Webserver in Enhancing e-Learning Access Capacity OLAT e-learning system (Translation of Penerapan e-learning OLAT dengan Webserver ter-cluster untuk meningkatkan kapasitas akses e-learning), *Proceeding of Seminar Nasional Aplikasi Teknologi Informasi SNATI 2010*, Yogyakarta, Indonesia, pp A85-A91.

URL, http://www.linuxvirtualserver.org/

Zulhaidi, H and Dipojono, H.K., 2002, On The Construction & Development of Simple PCs Cluster for High Performance Computers, Proceedings of Komputer dan Sistem Intelijen KOMMIT2002, Jakarta, Indonesia.